RECORDING MEDIUM HAVING DATA STRUCTURE FOR MANAGING RECORDING AND REPRODUCTION OF MULTIPLE PATH DATA RECORDED THEREON AND RECORDING AND REPRODUCING METHODS AND APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

[0001]The present invention relates to a recording medium having a data structure for managing reproduction of at least multiple reproduction path video data recorded thereon as well as methods and apparatuses for reproduction and recording.

Description of the Related Art

[0002]The standardization of new high-density read only and rewritable optical disks capable of recording large amounts of high-quality video and audio data has been progressing rapidly and new optical disk related products are expected to be commercially available on the market in the near future. The Blu-ray Disk Rewritable (BD-RW) is one example of these new optical disks.

[0003]Fig. 1 illustrates the file structure of the BD-RW. As shown, the data structure includes a root directory that contains at least one BDAV directory. The BDAV directory includes files such as 'info.bdav', 'menu.tidx', and 'mark.tidx', a PLAYLIST subdirectory in which playlist files (*.rpls and *.vpls) are stored, a CLIPINF subdirectory in which clip information files (*.clpi) are stored, and a STREAM subdirectory in which MPEG2-formatted A/V stream clip files (*.m2ts) corresponding to the clip information files are stored. In addition

to illustrating the data structure of the optical disk, Fig. 1 represents the areas of the optical disk. For example, the general information file info.bdav is stored in a general information area or areas on the optical disk.

[0004]Because the BD-RW data structure and disk format as illustrated in Fig. 1 is well-known and readily available, only a brief overview of the file structure will be provided in this disclosure.

[0005]As alluded to above, the STREAM directory includes MPEG2-formatted A/V stream files called clips. The STREAM directory may also include a special type of clip referred to as a bridge-clip A/V stream file. A bridge-clip is used for making seamless connection between two or more presentation intervals selected in the clips, and generally have a small data size compared to the clips. The A/V stream includes source packets of video and audio data. For example, a source packet of video data includes a header and a transport packet. A source packet includes a source packet number, which is generally a sequentially assigned number that serves as an address for accessing the source packet. Transport packets include a packet identifier (PID). The PID identifies the sequence of transport packets to which a transport packet belongs. Each transport packet in the sequence will have the same PID.

[0006]The CLIPINF directory includes a clip information file associated with each A/V stream file. The clip information file indicates, among other things, the type of A/V stream associated therewith, sequence information, program information and timing information. The sequence information describes the arrival time basis (ATC) and system time basis (STC) sequences.

For example, the sequence information indicates, among other things, the number of sequences, the beginning and ending time information for each sequence, the address of the first source packet in each sequence and the PID of the transport packets in each sequence. A sequence of source packets in which the contents of a program is constant is called a program sequence. The program information indicates, among other things, the number of program sequences, the starting address for each program sequence, and the PID(s) of transport packets in a program sequence.

[0007]The timing information is referred to as characteristic point information (CPI). One form of CPI is the entry point (EP) map. The EP map maps a presentation time stamp (e.g., on an arrival time basis (ATC) and/or a system time basis (STC) to a source packet address (i.e., source packet number).

[0008]The PLAYLIST directory includes one or more playlist files. The concept of a playlist has been introduced to promote ease of editing/assembling clips for playback. A playlist file is a collection of playing intervals in the clips. Each playing interval is referred to as a playitem. The playlist file, among other things, identifies each playitem forming the playlist, and each playitem, among other things, is a pair of IN-point and OUT-point that point to positions on a time axis of the clip (e.g., presentation time stamps on an ATC or STC basis). Expressed another way, the playlist file identifies the playitems, each playitem points to a clip or portion thereof and identifies the clip information file associated with the clip. The clip information file is used, among other things, to map the playitems to the clip of source packets.

[0009]A playlist directory may include real playlists (*.rpls) and virtual playlists (*.vpls). A real playlist can only use clips and not bridge-clips. Namely, the real playlist is considered as referring to parts of clips, and therefore, conceptually considered equivalent in disk space to the referred to parts of the clips. A virtual playlist can use both clips and bridge-clips, and therefore, the conceptual considerations of a real playlist do not exist with virtual playlists.

[0010]The info.bdav file is a general information file that provides general information for managing the reproduction of the A/V stream recorded on the optical disk. More specifically, the info.bdav file includes, among other things, a table of playlists that identifies the files names of the play list in the PLAYLIST directory of the same BDAV directory.

[0011]The menu.tidx, menu.tdt1 and menu.tdt2 files store information related to menu thumbnails. The mark.tidx, mark.tdt1 and mark.tdt2 files store information that relates to mark thumbnails. Because these files are not particularly relevant to the present invention, they will not be discussed further.

[0012]The standardization for high-density read-only optical disks such as the Blu-ray ROM (BD-ROM) is still under way. An effective data structure for managing reproduction of video and audio data recorded on the high-density read-only optical disk such as a BD-ROM is not yet available.

SUMMARY OF THE INVENTION

[0013]The recording medium has a data structure for managing reproduction of at least multiple reproduction path video data recorded on the

record medium. The recording medium includes at least one navigation area storing navigation management information for managing reproduction of the multiple recordation path video data recorded on the recording medium. The at least one navigation area has a plurality of angle change recording information corresponding to each of a plurality of data blocks.

[0014]In one exemplary embodiment, the at least one navigation area stores the plurality of angle change recording information in an entry point map.

[0015]The invention also includes a method of recording a data structure for managing reproduction of at least multiple reproduction path video data on a recording medium, the steps including recording navigation management information for managing reproduction of multiple reproduction path video data in at least one navigation area of the recording medium, said at least one navigation area having a plurality of angle change recording information corresponding to each of a plurality of data blocks.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]The above features and other advantages of the present invention will be more clearly understood from the following detailed description with the accompanying drawings in which:

[0017]Fig. 1 illustrates the prior art file or data structure of a rewritable optical disk according to the Blu-ray Disc Rewritable (BD-RW) standard;

[0018]Fig. 2 illustrates an exemplary embodiment of a recording medium file or data structure according to the present invention;

[0019]Fig. 3 illustrates an example of a recording medium in accordance with the present invention;

[0020]Fig. 4 illustrates a Contained Self-Encoded Stream Format transport stream for use in the data structure according to Fig. 2;

[0021]Fig. 5 illustrates an exemplary embodiment of a data structure for an entry point map that is recorded and managed by a search information management method for a high-density optical disk in accordance with the present invention;

[0022]Fig. 6 illustrates an exemplary embodiment of an entry point map which is recorded and managed by a search information management method for a high-density optical disk in accordance with the present invention;

[0023]Fig. 7 illustrates a schematic diagram of an embodiment of an optical disk recording and reproduction apparatus of the present invention; and

[0024]Fig. 8 illustrates a multi-angle playback process based on a search information management method for a high-density optical disk in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025]In order that the invention may be fully understood, preferred embodiments thereof will now be described with reference to the accompanying drawings.

[0026]A high-density optical disk, for example, a Blu-ray ROM (BD-ROM) in accordance with the present invention may have a file or data structure for

managing reproduction of video and audio data as shown in Fig. 2. Many aspects of the data structure according to the present invention shown in Fig. 2 are similar to that of the BD-RW standard discussed with respect to Fig. 1. As such these aspects will not be described in great detail.

[0027]As shown in Fig. 2, the root directory contains at least one DVP directory. The DVP directory includes a general information file info.dvp, menu files menu.tidx, menu.tdt1 among others, a PLAYLIST directory in which playlist files (e.g., real (*.rpls) and virtual (*.vpls)) are stored, a CLIPINF directory in which clip information files (*.clpi) are stored, and a STREAM directory in which MPEG2-formatted A/V stream clip files (*.m2ts), corresponding to the clip information files, are stored.

[0028]The STREAM directory includes MPEG2-formatted A/V stream files called clips. The STREAM directory may also include a special type of clip referred to as a bridge-clip A/V stream file. A bridge-clip is used for making seamless connection between two or more presentation intervals selected in the clips, and generally have a small data size compared to the clips. The A/V stream includes source packets of video and audio data. For example, a source packet of video data includes a header and a transport packet. A source packet includes a source packet number, which is generally a sequentially assigned number that serves as an n address for accessing the source packet. Transport packets include a packet identifier (PID). The PID identifies the sequence of transport packets to which a transport packet belongs. Each transport packet in the sequence will have the same PID.

[0029]The CLIPINF directory includes a clip information file associated with each A/V stream file. The clip information file indicates, among other things, the type of A/V stream associated therewith, sequence information, program information and timing information. The sequence information describes the arrival time basis (ATC) and system time basis (STC) sequences. For example, the sequence information indicates, among other things, the number of sequences, the beginning and ending time information for each sequence, the address of the first source packet in each sequence and the PID of the transport packets in each sequence. A sequence of source packets in which the contents of a program is constant is called a program sequence. The program information indicates, among other things, the number of program sequences, the starting address for each program sequence, and the PID(s) of transport packets in a program sequence.

[0030]The timing information is referred to as characteristic point information (CPI). One form of CPI is the entry point (EP) map. The EP map maps a presentation time stamp (e.g., on an arrival time basis (ATC) and/or a system time basis (STC)) to a source packet address (i.e., source packet number).

[0031]The PLAYLIST directory includes one or more playlist files. The concept of a playlist has been introduced to promote ease of editing/assembling clips for playback. A playlist file is a collection of playing intervals in the clips. Each playing interval is referred to as a playitem. The playlist file, among other things, identifies each playitem forming the playlist, and each playitem, among other things, is a pair of IN-point and OUT-point that point to positions on a time

axis of the clip (e.g., presentation time stamps on an ATC or STC basis). Expressed in another way, the playlist file identifies playitems, each playitem points to a clip or portion thereof and identifies the clip information file associated with the clip. The clip information file is used, among other things, to map the playitems to the clip of source packets.

[0032]A playlist directory may include real playlists (*.rpls) and virtual playlists (*.vpls). A real playlist can only use clips and not bridge-clips. Namely, the real play list is considered as referring to parts of clips, and therefore, conceptually considered equivalent in disk space to the referred to parts of the clips. A virtual playlist can use both clips and bridge-clips, and therefore, the conceptual considerations of a real playlist do not exist with virtual playlists.

[0033]The info.dvp file is a general information file that provides general information for managing the reproduction of the A/V streams recorded on the optical disk. More specifically, the info.dvp. file includes, among other things, a table of playlists that identifies the file names of the playlists in the PLAYLIST directory. The info.dvp file will be discussed in greater detail below with respect to the embodiments of the present invention.

[0034]In addition to illustrating the data structure of the recording medium according to an embodiment of the present invention, Fig. 2 represents the areas of the recording medium. For example, the general information file is recorded in one or more general information areas, the playlist directory is recorded in one or more playlist directory areas, each playlist in a playlist directory is recorded in one or more playlist areas of the recording medium, etc.

Fig. 3 illustrates an example of a recording medium having the data structure of Fig. 2 stored thereon. As shown, the recording medium includes a file system information area, a data base area and an A/V stream area. The data base area includes a general information file and playlist information area and a clip information area. The general information file and playlist information area have the general information file recorded in a general information file area thereof, and the PLAYLIST directory and playlist files recorded in a playlist information area thereof. The clip information area has the CLIPINFO directory and associated clip information files recorded therein. The A/V stream area has the A/V streams for the various titles recorded therein.

[0035]Video and audio data are typically organized as individual titles; for example, different movies represented by the video and audio data are organized as different titles. Furthermore, a title may be organized into individual chapters in much the same way a book is often organized into chapters.

[0036]Because of the large storage capacity of the newer, high-density recording media such as BD-ROM optical disks, different titles, various versions of a title or portions of a title may be recorded, and therefore, reproduced from the recording media. For example, video data representing different camera angles may be recorded on the recording medium. As another example, versions of title or portions thereof associated with different languages may be recorded on the recording medium. As a still further example, a director's version and a theatrical version of a title may be recorded on the recording medium. Or, an adult version, young adult version and young child version (i.e.,

different parental control versions) of a title or portions of a title may be recorded on the recording medium. Each version represents a different reproduction path, and the video data in these instances is referred to as multiple reproduction path video data. It will be appreciated that the above examples of multiple reproduction path video data are not limiting, and the present invention is applicable to any type or combination of types of multiple reproduction path video data. As will be described in detail below with respect to embodiments of the present invention, the data structures according to the present invention include path management information and/or navigation information for managing reproduction of multiple reproduction path video data recorded on the recording medium.

[0037]Fig. 4 shows a Self-Encoded Format Transport Stream (SESF) having a plurality of SEFS capsules. Each of the SEFS capsules has a TIP source packet, followed by a multiplexing unit of video data packets "V". One constrained SEFS TS consists of one or more SESF capsules, and each SESP capsule starts with a SESF TIP packet. Every TIP contains audio or video stream information for succeeding source packets. The audio/video stream also contains a program map table (PMT), that is a TS packet that contains the PIDs for each of the elementary streams. A program association table (PAT), which is also a TS packet, carries the PIDs that identify various PMTs.

[0038]Fig. 5 illustrates a portion of the clip information file according to an embodiment of the present invention. As shown, the EP_map_for_one_stream_PID entry is used to populate a table of PTS values and

addresses for packets having the same PID in a single elementary stream. These tables collectively define an EP map that is part of the data structure's characteristic point information (CPI) that relates the time information in the AV stream with the address information in the AV stream.

[0039]In order to reduce the size of the table and to improve the searching performance of the system, the EP_map_for_one_stream_PID is divided into two sub tables: EP_coarse and EP_fine. EP_fine contains the least significant bits (LSB) from the presentation time stamp start and the source packet number start for each of the packets associated with a PID. EP_coarse refers to EP_fine and contains the most significant bits (MSB) of the presentation time stamp start, the source packet number and the EP_fine number that corresponds to the EP_coarse entry having the same presentation time stamp start. The number of entries in the EP_coarse sub table is comparatively less than the EP_fine sub table.

[0040]The entry map for EP_map_for_one_stream_PID stores the presentation time stream entry point (PTS_EP_start) and the entry point of address (SPN_EP_start) to manage source packets in an audio/video stream corresponding to the same PID.

[0041]The EP_fine_table_start_address is the start address of the first EP_video_type_(EP_fine_id) field in relative byte number from the first byte of the EP_map_for_one_stream_PID(). The ref_to_EP_fine_id is the EP_fine entry number that contains the PTS_EP_fine that relates to the PTS_EP_coarse immediately following this field. PTS_EP_coarse and SPN_EP_coarse are both

derived from the PTS_EP_start for the entry point.

[0042]For each EP map entry, the combination of the EP_video_type (EP_fine_id) and I_end_position_offset (EP_fine_id) defines various conditions. For example, if the I_end_position_offset (EP_fine_id) set to a value other than "000", for particular video types, this indicates that the offset address of the end of a video access unit that includes an I-picture pointed to by the SPN_EP_start.

[0043]Fig. 6 shows possible combinations of some of the foregoing parameters stored in the EP map that may be used to set certain conditions in the data structure such as a change angle request. In Fig. 6, the various factors shown include the EP_video_type (EP_fine_id), I_end_position_offset (EP_fine_id), PTS_EP_fine and SPN_EP_fine.

[0044]Where the EP_video_type is set to "0", the PTS_EP_fine and the SPN_Entry_fine become the values that correspond to TIP packet start SPN of the head of the SESF capsule.

[0045]In the second condition, the EP_video_type is set to "1" and the I_end_position_offset is set to "000". The PTS_EP_fine and the SPN_EP_fine are placed into the values that correspond to first I-Picture end relative to source packet number (first_I-end_relative_SPN).

[0046]In the third condition, the I-Picture end position offset is '001', the PTS_EP_fine and the SPN_EP_fine become the values that correspond to the first P-picture end relative source packet number (first_P_end_relative_SPN); and when the I-picture end position offset is '010', the PTS_EP_fine and the SPN_EP_fine become the values that correspond to the second P-picture end

relative source packet number (second_P_end_relative SPN).

[0047]In the fourth condition, when the I-picture end position offset is '100', the PTS_EP_fine and the SPN_EP_fine become the values that correspond to the Angle Change (or AC) or the Interleaved Unit end relative source packet number (ILVU_end_relative_SPN). Namely, this confirms where an angle change is permitted.

[0048]Each of the aforementioned conditions are offered to show a more efficient method of recording, reproducing and managing of data on a optical disk by recording certain information in an EP map and using this information to determine critical points in the data structure.

[0049]Fig. 7 illustrates a schematic diagram of an embodiment of an optical disk recording and reproducing apparatus according to the present invention. As shown, an AV encoder 9 receives and encodes audio and video data. The AV encoder 9 outputs the encoded audio and video data along with coding information and stream attribute information. A multiplexer 8 multiplexes the encoded audio and video data based on the coding information and stream attribute information to create, for example, an MPEG2 transport stream. A source packetizer 7 packetizes the transport packets from the multiplexer 8 into source packets in accordance with the audio/video format of the optical disk. As shown in Fig. 7, the operations of the AV encoder 9, the multiplexer 8 and the source packetizer 7 are controlled by a controller 10. The controller 10 receives user input on the recording operation, and provides control information to AV encoder 9, multiplexer 8 and the source packetizer 7.

For example, the controller 10 instructs the AV encoder 9 on the type of encoding to perform, instructs the multiplexer 8 on the transport stream to create, and instructs the source packetizer 7 on the source packet format. The controller 10 further controls a drive 3 to record the output from the source packetizer 7 on the optical disk.

[0050]The controller 10 also creates the navigation and management information for managing reproduction of the audio/video data being recorded on the optical disk. For example, based on information received via the user interface (e.g., instruction set saved on disk, provided over an intranet or internet by a computer system, etc.), the controller 10 controls the drive 3 to record the data structure of Figs. 2, 3, 5 or 6 on the optical disk.

[0051]During reproduction, the controller 10 controls the drive 3 to reproduce this data structure. Based on the information contained therein, as well as user input received over the user interface (e.g., control buttons on the recording and reproducing apparatus or a remote associated with the apparatus), the controller 10 controls the drive 3 to reproduce the audio/video source packets from the optical disk. For example, the user input may specify a path to reproduce. This user input may be specified, for example, via a menu based graphical user interface preprogrammed into the controller 10. Using the user input and the path management information reproduced from the optical disk, the controller 10 controls the reproduction of the specified path.

[0052]For example, to execute an angle change, a user inputs a request for an angle change via the user interface into the controller 10. The controller

10 then determines the number of reproduction paths, and that the user has requested an angle change. The controller 10 also determines if the user's request is permitted by referencing the EP map. Depending on the information stored in the EP map, the change angle request may be immediately processed, delayed and/or refused.

[0053]The reproduced source packets are received by a source depacketizer 4 and converted into a data stream (e.g., an MPEG-2 transport packet stream). A demultiplexer 5 demultiplexes the data stream into encoded video and audio data. An AV decoder 6 decodes the encoded video and audio data to produce the original audio and video data that was fed to the AV encoder 9. During reproduction, the controller 10 controls the operation of the source depacketizer 4, demultiplexer 5 and AV decoder 6. The controller 10 receives user input on the reproducing operation, and provides control information to AV decoder 6, demultiplexer 5 and the source packetizer 4. For example, the controller 10 instructs the AV decoder 9 on the type of decoding to perform, instructs the demultiplexer 5 on the transport stream to demultiplex, and instructs the source depacketizer 4 on the source packet format.

[0054]While Fig. 7 has been described as a recording and reproducing apparatus, it will be understood that only a recording or only a reproducing apparatus may be provided using those portions of Fig. 8 providing the recording or reproducing function.

[0055]Fig. 8 illustrates application of the described data management system for executing an angle change by detecting a flag recorded in the

EP_map_for_one_stream_PID. As shown in Fig. 8, multiple reproduction path data are recorded in the unit of Angle Block which is divided by the fourth condition of Fig. 6 in which the PTS_EP_fine and the SPN_EP_fine have the values that correspond to the Angle Change (or AC) or the Interleaved Unit end relative source packet number (ILVU_end_relative_SPN). The data for one reproduction path are recorded as one or more Angle Blocks, and the Angle Blocks are interleaved.

[0056]When a user requests an angle change to a second angle Angle 2 while playing the data stream of a first angle Angle 1, an angle change may only be executed when a predetermined condition exists for selected parameters as recorded in the EP map as discussed in detail below.

[0057]In this example, upon receiving the angle change request, the system reviews the EP map to determine if the angle change request is permitted. By comparing the address information for the audio/video stream with the information stored in the EP, the system determines that address information does not correspond to condition 4 in Fig. 6, i.e., the angle change request does not occur at permitted angle point. As illustrated in Fig. 9, the angle change request is delayed until the system reaches the end of the Angle Block, and condition 4 of Fig. 6 is met, that permits processing of the angle change. Upon execution of the angle change request, the system skips to Angle Block 2 in the A/V stream to the SPN_start address for the requested angle, in this case, the second data block of Angle Block (Angle 2).

[0058]Although the detailed description of the invention has been directed

to certain exemplary embodiments, various modifications of these embodiments, as well as alternative embodiments, will be suggested to those skilled in the art. The invention encompasses any modifications or alternative embodiments that fall within the scope of the claims.